Fuels

The ability to predict fire behavior and rate fire danger became possible with the development of fuel models for specific types of fuels. The fuel models used in this assessment are those developed by the United States Department of Agricultural - Forest Service[5] and are described in "Aid to Determining Fuel Models for Estimating Fire Behavior" (Anderson, Hal; 1982)

Understanding the current fuel situation in the unit is paramount in determining the fire risk to assets. Fuel is any organic material that is living or dead, in or on the ground or above ground level that can ignite and burn. Fuels are usually classified into four groups; grasses, brush, timber and logging slash. The fuel bed is a complex system that includes seven principal characteristics: fuel loading, fuel size and shape, compactness, horizontal continuity, vertical arrangement, chemical content and moisture content.[6] The combined effects of fuel, weather, and topography determine how fire behaves.

Definitions

Fuel Loading:
: The mass of fuel per unit area, live and dead, grouped by particle size classes, expressed in tons per acre.

Fuel Size and Shape:
: The surface-area-to-volume ratio. Typically small flat fuels such as grass have a higher surface-area-to-volume than larger fuels such as logs.

Fuel Compactness:
: The spacing between fuel particles. Closely compacted fuels have less surface area exposed, restrict oxygen, and inhibit convective and radiant heat transfer.

Fuel Horizontal Continuity:
: Horizontal distribution of fuels at various levels or planes. Continuous horizontal fuels allow the fire to spread easier than sparsely distributed horizontal fuels.

Fuel Vertical Arrangement:
: The relative height of fuels located above the ground. This is the ladder fuel component.

Chemical Content:
: Chemicals makeup of individual fuel. Some fuels contain chemical compounds that are more volatile than others.

Moisture Content:
: The amount of water in fuel expressed as the percentage of the oven-dry weight of the same fuel.

[5] Albini, "Estimating Wildfire Behavior Effects" and Rothermel "How to Predict the Spread and Intensity of Forest and Range Fires".
[6] Intermediate Wildland Fire Behavior S-290

In order to consider the fuel bed characteristics the Fire Plan fuels assessment categorizes fuels in three broad levels – Surface fuels, Ladder fuels, and Crown Fuels. Combining these fuel levels with topography (slope) allows a fuel hazard ranking.

Surface Fuels

The fuel at ground level that is most likely to carry the fire; for example grass, pine needles or leaves, brush, or slash. This fuel will carry active fire without the addition of wind or topographic influence.

The surface fuel in the left foreground is a grass fuel model 1. The surface fuel model below is a fuel model 9, needle and leaf litter with the majority of ground litter less than three inches in diameter.

The fuel at the left is a brush model. This particular brush has sufficient dead fuel loading to qualify it as a fuel model 4.

Ladder Fuels

This is the vertical arrangement component of fuels. These fuels might consist of small trees, brush, low hanging branches, and leaf or needle litter suspended in the branches of shrubs of trees. This fuel is typically ignited by surface fuel fire. The burning of the ladder fuels easily allows the fire to move into the canopy fuels or if the canopy is open to cause individual torching of trees.

In the foreground of the left photograph grass, leaf litter, and dead woody material can carry the fire to the brush that in turn ignites the lower branches of the trees.

In the photograph at the right the forest floor grasses and leaf/needle litter can ignite the younger trees and shrubs and take the fire to the crown of the trees.

Both of these depict a continuous horizontal and vertical arrangement of the fuels.

Crown Fuels

This is the tops of the vegetation whether timber or tall shrubs. Canopy closure is the major concern. Canopy closure is usually given as a percentage. It can be demonstrated by looking at the canopy from the air and seeing what percentage of the ground is visible. If 25% of the ground is visible than there is a 75% canopy closure. Typically a crown fire will be sustained if the canopy closure is greater than 50%. Unless strong winds are present, crowning fires are unlikely without a closed canopy.

Here a fire is burning in a mixed coniferous forest where continuous crown fuels exist. This area also has widespread, continuous ladder fuels.

In the foreground of this photograph, both the ladder and continuous crown fuels have been removed creating a more fire safe environment.

The following three maps indicate the fuel rankings for surface, ladder and crown fuels. The fourth map calculates a total fuel ranking which combines the fuels and slope factor. The crown and ladder fuels in the timber belts within the State Responsibility Area were reassessed in 2002. The fuels were not reassessed in the USFS protection area and have a lower ranking on these maps. Sample evaluations indicate that the crown and ladder scores in the USFS DPA should be elevated. An additional three maps indicate the surface fuel types of the Unit.

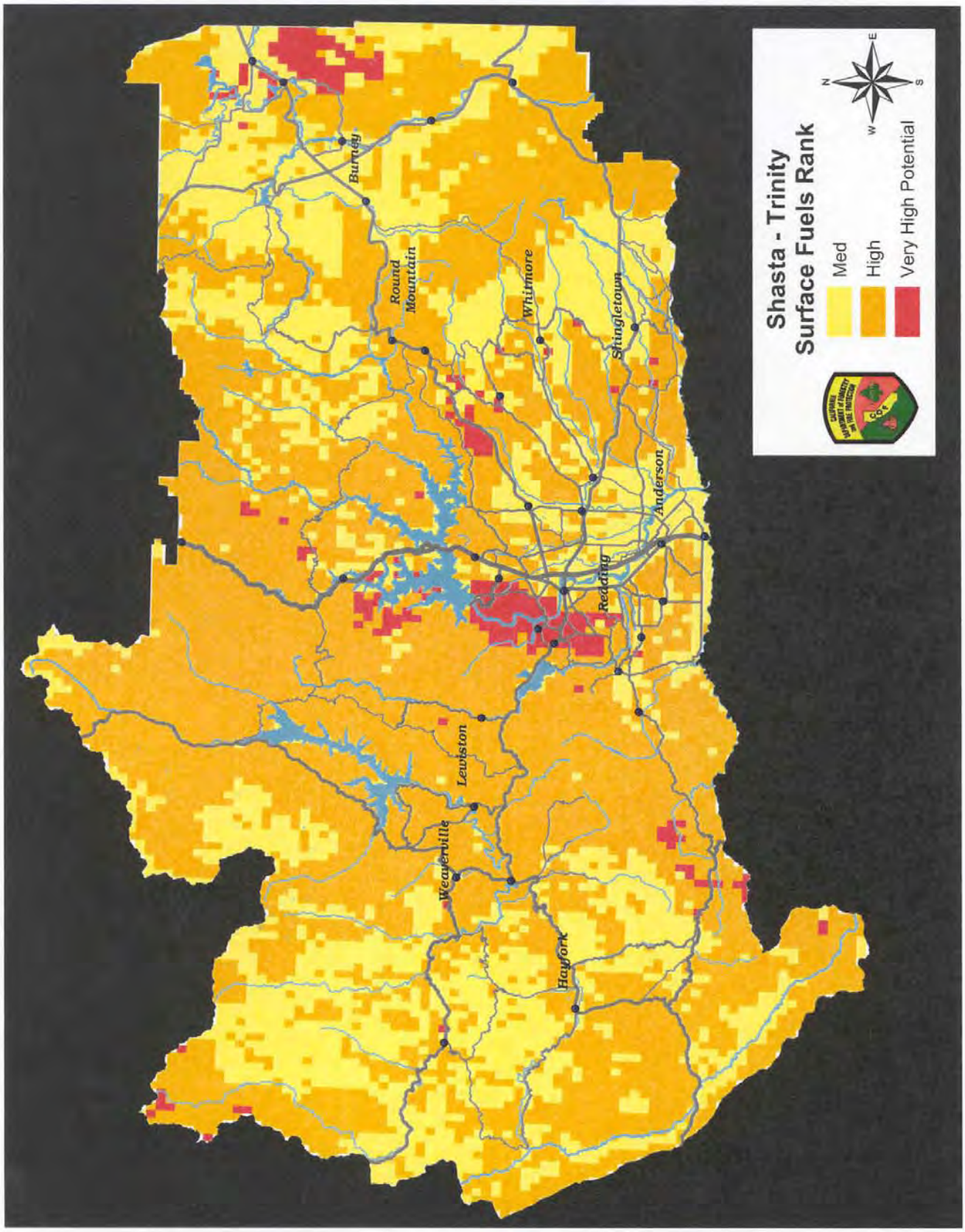
The Unit's brush belt fuel types and fuel ranking are in error. Sampling of the Brush Zone indicates that the crown and ladder fuels are at a higher volume than indicated. The Brush Zone shown on the Grass and Brush Zone fuel map indicates grass in many areas where brush has become the primary surface fuel. A goal for the fire plan is to ground truth the brush and grass fuel zones. Some fuel corrections were made in the urbanized areas west of Redding in 2003. ***Maps utilizing the current fuel data indicate a lower fuel ranking than actually exists in portions of the Brush and Grass Zones.***

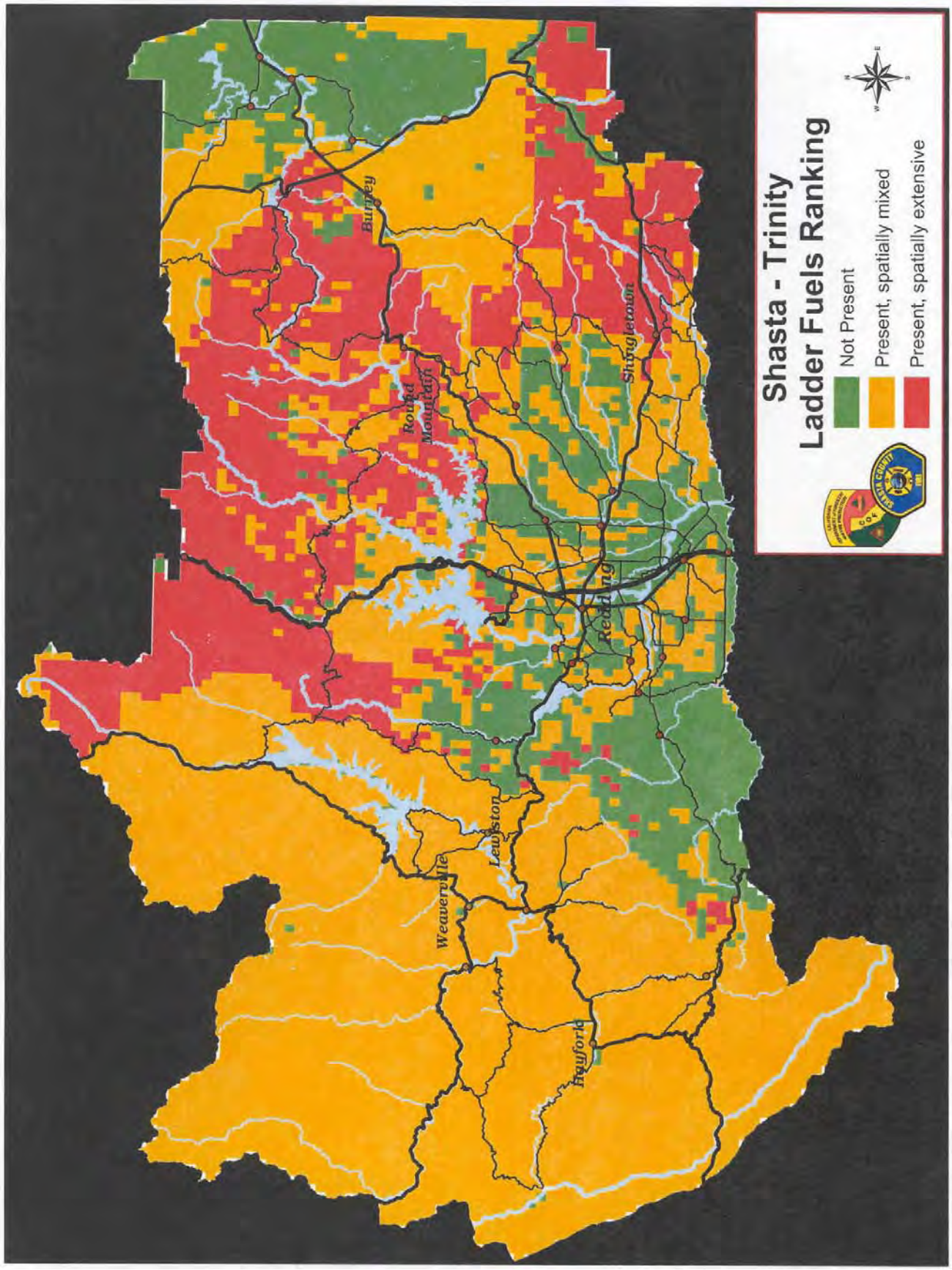
The following guidelines are used to rank the Q81st fuels. The ranking considers both the spatial continuity of the fuel attribute and how much area of the Q81st cell is covered.

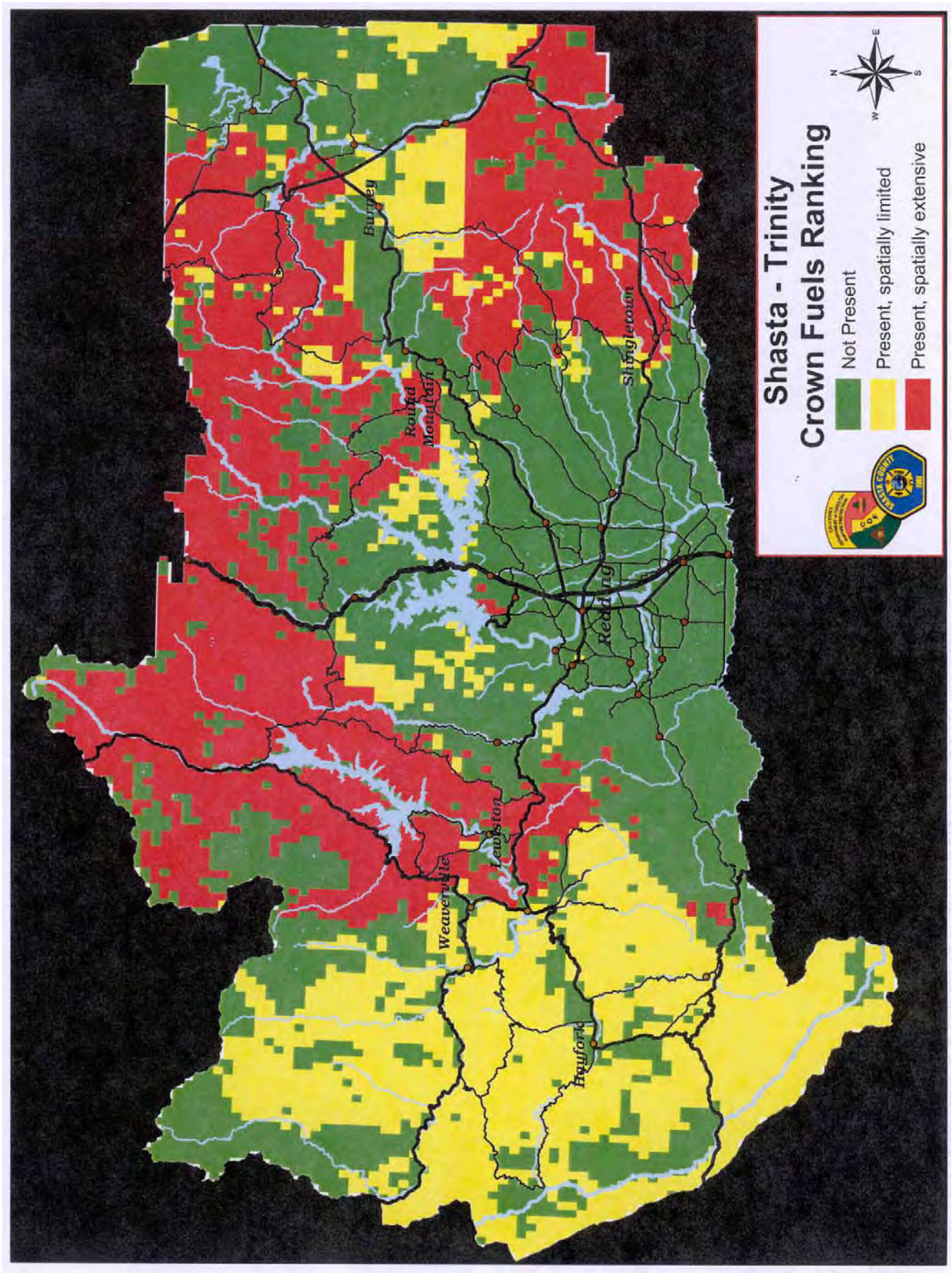
	Ladder Fuel Continuity	***% of Q81 Area***
Not Present	< 30% Ladder Fuel Canopy	>99%
Present, Spatially Limited	> 30% Ladder Fuel Canopy	1 - 25%
Present, Spatially Extensive	> 30% Ladder Fuel Canopy	> 25%
	Crown Fuel Continuity	***% of Q81 Area***
Not Present	< 50% Over story Canopy	>99%
Present, Spatially Limited	> 50% Over story Canopy	1 - 25%
Present, Spatially Extensive	> 50% Over story Canopy	> 25%

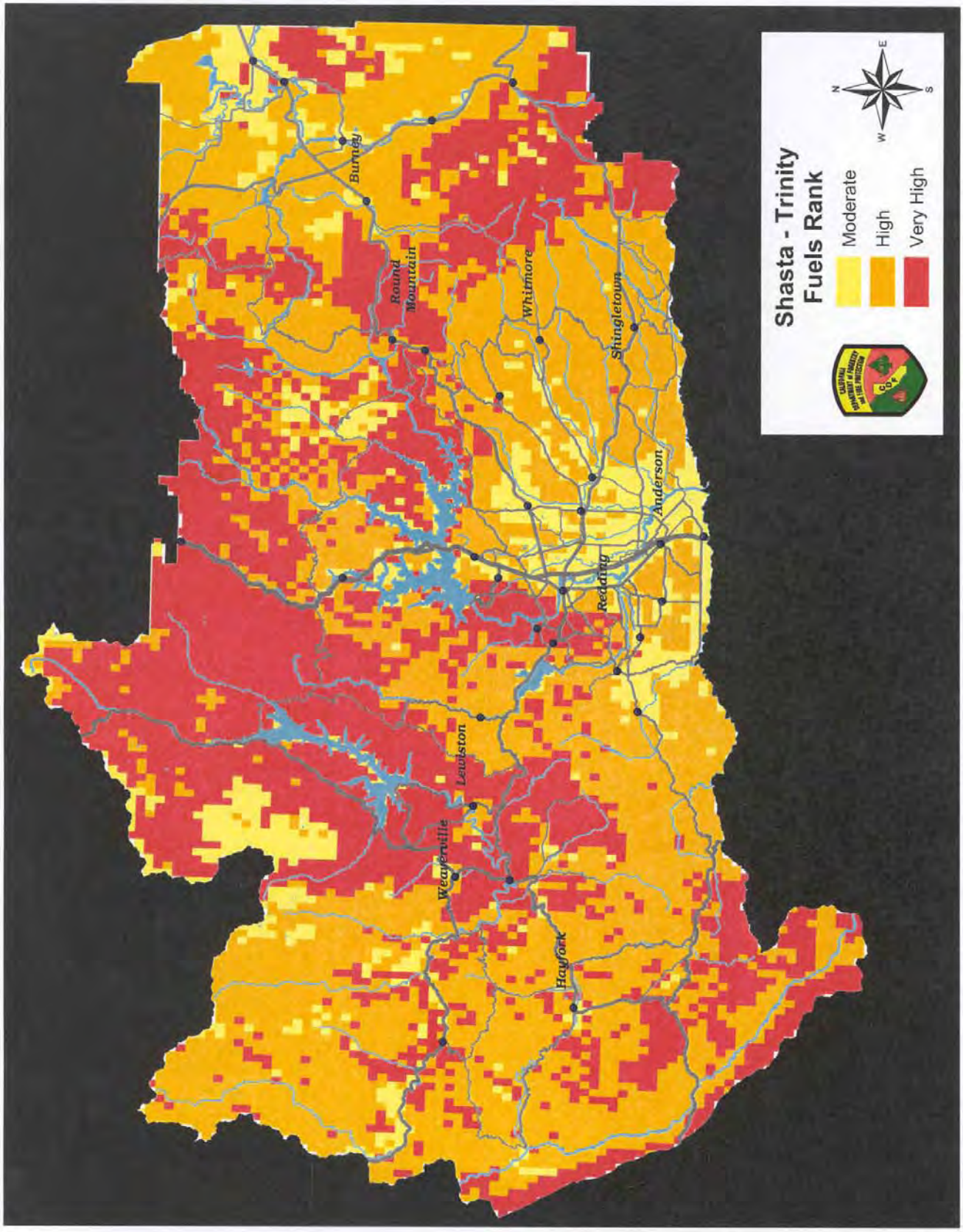
The fuel hazard ranking system is based on estimates of potential fire behavior associated with the particular fuel type: and as such have a direct relationship to the characteristics – rate of spread, fire line intensity, heat intensity, heat per unit area, etc.- that are a result of that fuel complex burning under a particular set of weather conditions. The idea is to provide a basic means of stratifying the landscape into areas of low, medium, and high hazard as it is related to fire behavior potential.[7]

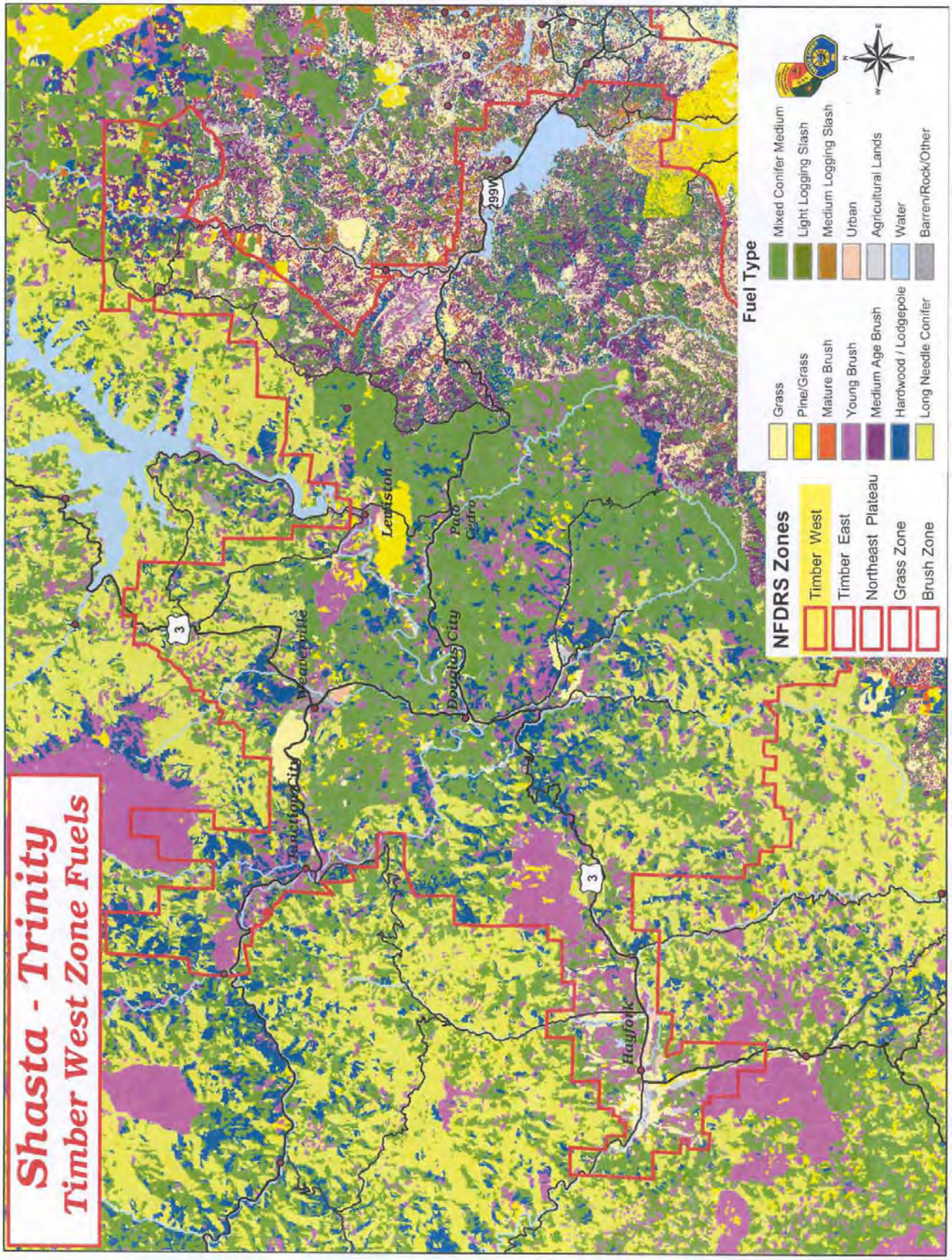
[7] Appendix VIII of the "Unit Vegetation-based Products" of the California Fire Plan

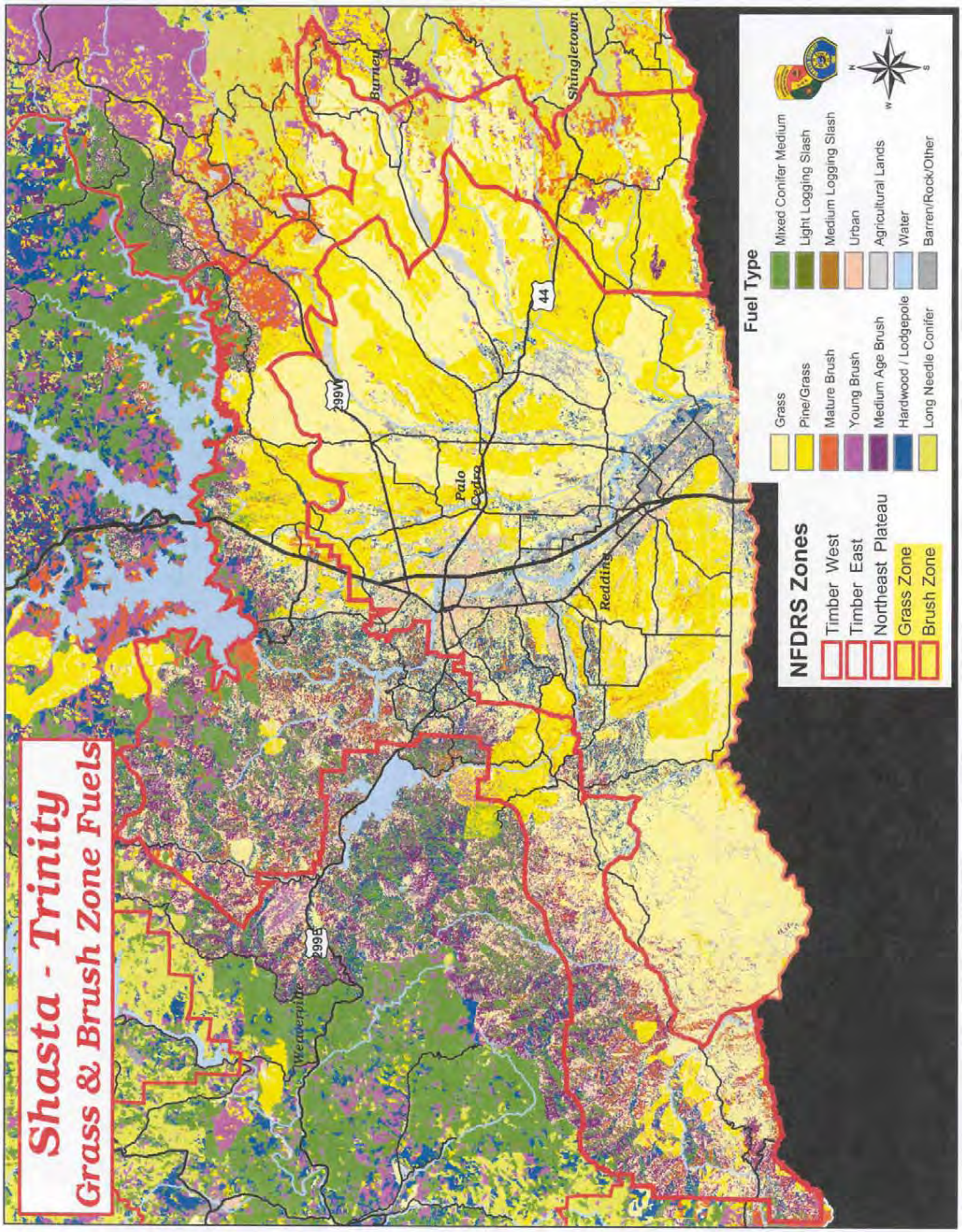

Shasta - Trinity
Surface Fuels Rank
Med
High
Very High Potential
N
E
S
W
Burney
Round Mountain
Whitmore
Shingletown
Anderson
Redding
Lewiston
Weaverville
Hayfork

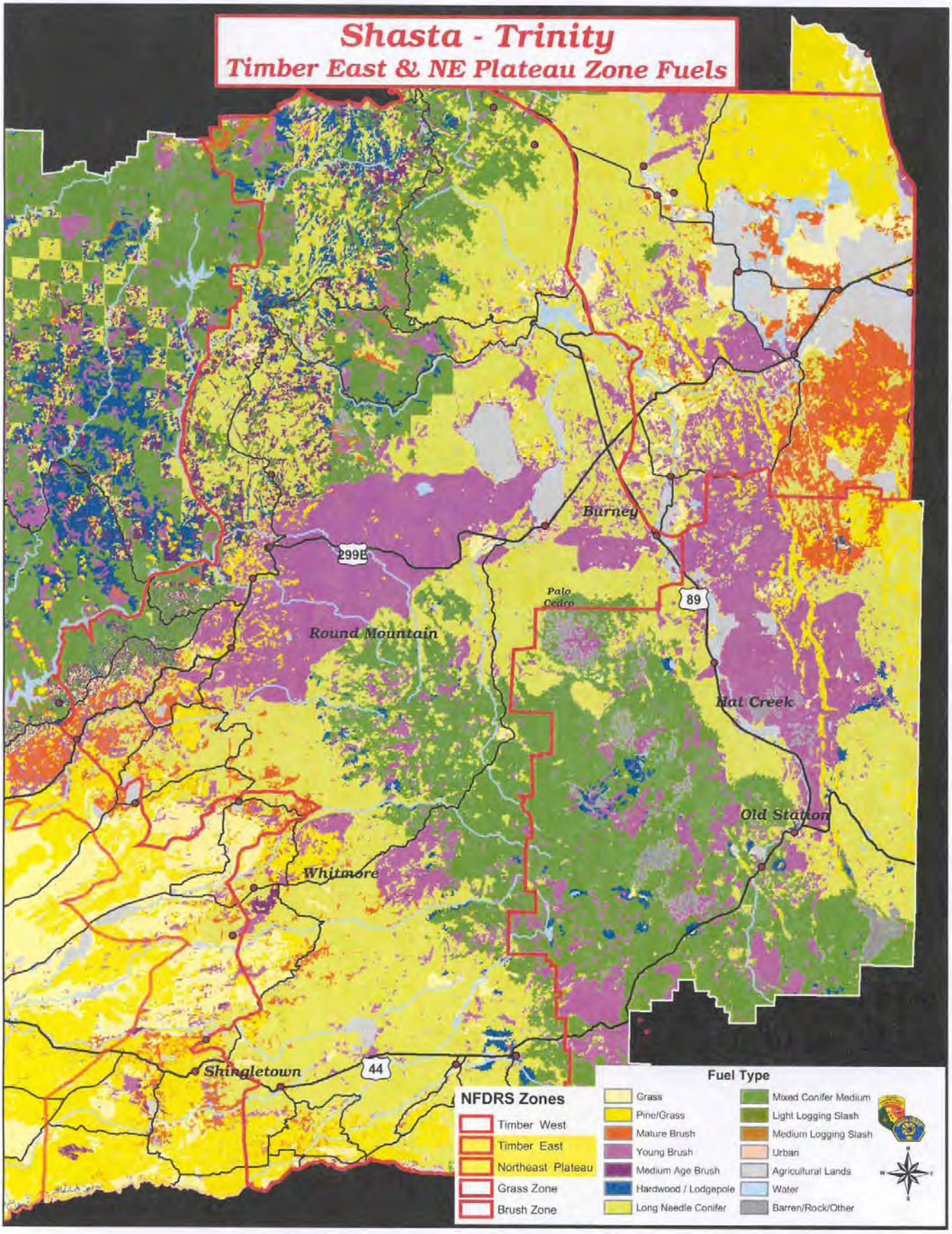

Shasta - Trinity
Ladder Fuels Ranking
Not Present
Present, spatially mixed
Present, spatially extensive
Burney
Round Mountain
Shingletown
Redding
Weaverville
Lewiston
Hayfork


Shasta - Trinity
Crown Fuels Ranking
Not Present
Present, spatially limited
Present, spatially extensive
N
E
S
W
Burney
Round Mountain
Shingletown
Redding
Lewiston
Weaverville
Hayfork


Shasta - Trinity
Fuels Rank
Moderate
High
Very High
N
E
S
W
Burney
Round Mountain
Whitmore
Shingletown
Anderson
Redding
Lewiston
Weaverville
Hayfork


Shasta - Trinity
Timber West Zone Fuels
Fuel Type
Grass
Pine/Grass
Mature Brush
Young Brush
Medium Age Brush
Hardwood / Lodgepole
Long Needle Conifer
Mixed Conifer Medium
Light Logging Slash
Medium Logging Slash
Urban
Agricultural Lands
Water
Barren/Rock/Other
NFDRS Zones
Timber West
Timber East
Northeast Plateau
Grass Zone
Brush Zone
Lewiston
Douglas City
Weaverville
Hayfork
299W
3


Shasta - Trinity
Grass & Brush Zone Fuels
Burney
Shingletown
44
299W
Palo Cedro
Redding
299E
Weaverville
NFDRS Zones
Timber West
Timber East
Northeast Plateau
Grass Zone
Brush Zone
Fuel Type
Grass
Pine/Grass
Mature Brush
Young Brush
Medium Age Brush
Hardwood / Lodgepole
Long Needle Conifer
Mixed Conifer Medium
Light Logging Slash
Medium Logging Slash
Urban
Agricultural Lands
Water
Barren/Rock/Other


Shasta - Trinity
Timber East & NE Plateau Zone Fuels
Burney
299E
Palo Cedro
89
Round Mountain
Hat Creek
Old Station
Whitmore
Shingletown
44
NFDRS Zones
Timber West
Timber East
Northeast Plateau
Grass Zone
Brush Zone
Fuel Type
Grass
Pine/Grass
Mature Brush
Young Brush
Medium Age Brush
Hardwood / Lodgepole
Long Needle Conifer
Mixed Conifer Medium
Light Logging Slash
Medium Logging Slash
Urban
Agricultural Lands
Water
Barren/Rock/Other